Soft X-Ray Spectroscopy of Noble Gas Atoms Doped in Solid Matrices

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We have measured the soft x-ray emission and absorption spectra of noble-gas atoms doped in carbon, silicon and metal substrates, to investigate their chemical states in solid matrices. Argon or neon ion beams were directed into the solid matrices of highly oriented pyrolytic graphite (HOPG), Si(111), SiO_2, Ti, Cr, Ni and Cu with an acceleration voltage of 5 kV. Soft x-ray emission and absorption spectra in the Ar *L* and Ne *K* regions of Ar- and Ne-doped samples were measured using a grating x-ray spectrometer installed in the undulator beamline, BL-8.0.1. Figure 1 shows the Ar *L* x-ray emission spectra of Ar-doped Si(111) measured with excitation energies of (a) 399.6 eV and (b) 256.6 eV. The subtracted spectrum of (a) – (b), clearly indicates that peak structures are observed on the higher-energy sides of both $L\alpha$ and $L\beta$ peaks arising from 399.6-eV excitation. These peak structures may be due to multiple ionizations. Figure 2 shows the Ar *L* x-ray emission spectra of Ar-doped Si(111), HOPG, Ti and Cu measured with 256.6-eV excitation. Peak widths of $L\alpha$ and $L\beta$ peaks in the Ar *L* x-ray emission spectra from Ti and Cu matrices are broader than that of the Si(111) and HOPG matrices. A similar peak broadness was also observed in the Ne *K* x-ray emission spectra of Ne-doped metal matrices. Such peak broadness may be explained by the formation of noble gas bubbles in the metals. To further explain peak broadness in the spectra, molecular orbital calculations are currently in progress. We thank Dr. J. Denlinger of the Lawrence Berkeley National Laboratory for his help and support in performing x-ray emission measurements. This work has been supported by the Hyogo Science and Technology Association and the US Department of Energy under contract No. DE-AC03-76SF00098. Principal Investigator: Yasuji Muramatsu, Japan Atomic Energy Research Institute. Email: murama@spring8.or.jp. Telephone: +81-791-58-2601.

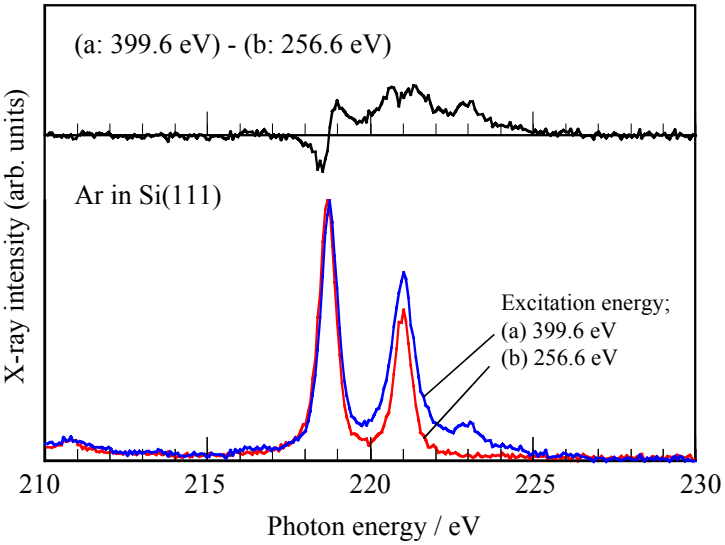

Figure 1 Ar *L* x-ray emission spectra of Ar-doped Si(111) with excitation energies of (a) 399.6 eV and (b) 256.6 eV. Upper panel shows the subtracted spectrum, (a) – (b).

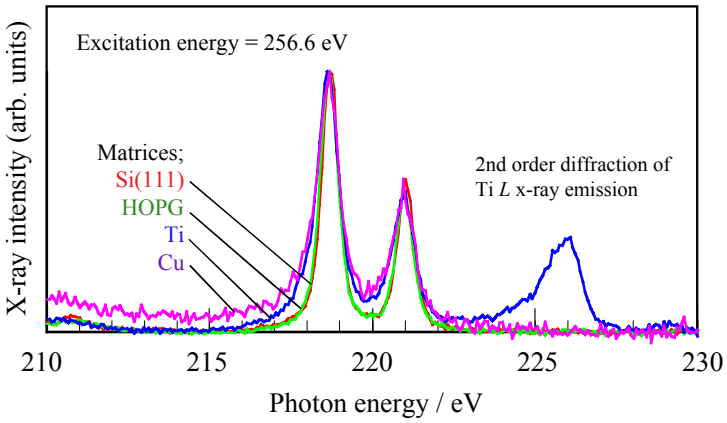

Figure 2 Ar *L* x-ray emission spectra of Ar-doped Si(111), HOPG, Ti, and Cu matrices. Excitation energy was tuned to 256.6 eV.